FIG.1

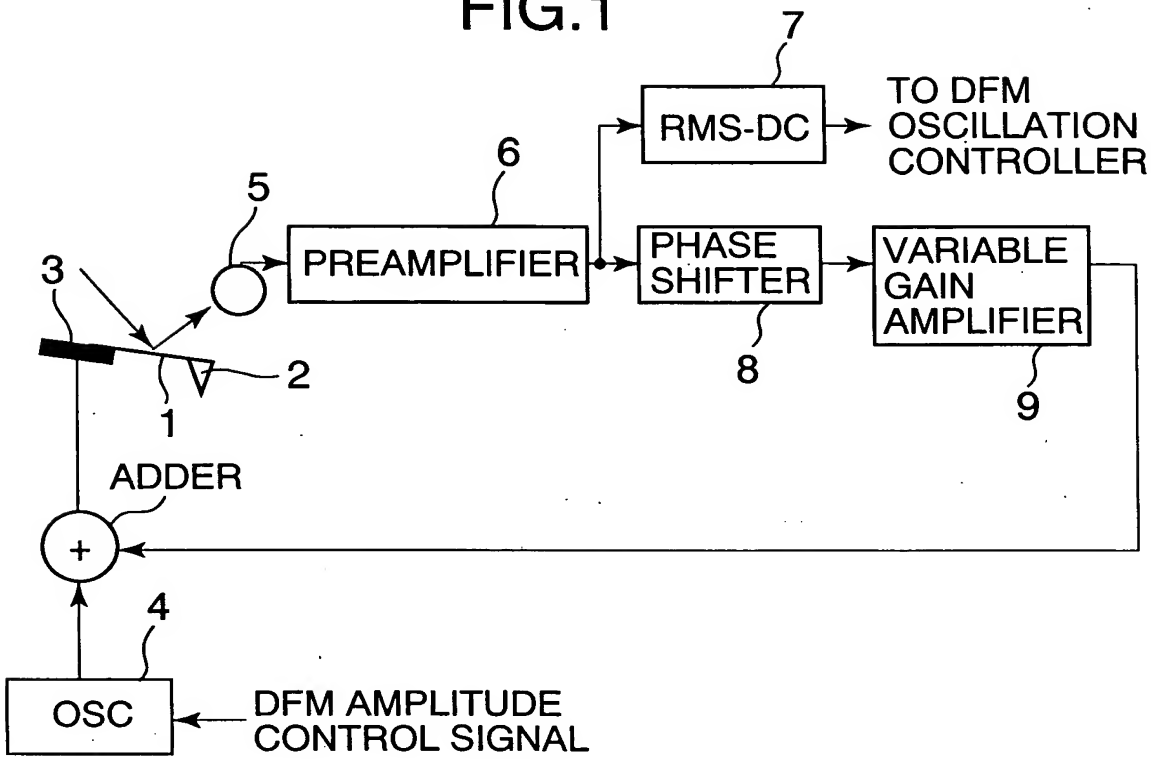

7
RMS-DC
TO DFM OSCILLATION CONTROLLER
6
5
PREAMPLIFIER
PHASE SHIFTER
VARIABLE GAIN AMPLIFIER
3
2
1
8
9
ADDER
+
4
OSC
DFM AMPLITUDE CONTROL SIGNAL

FIG.2

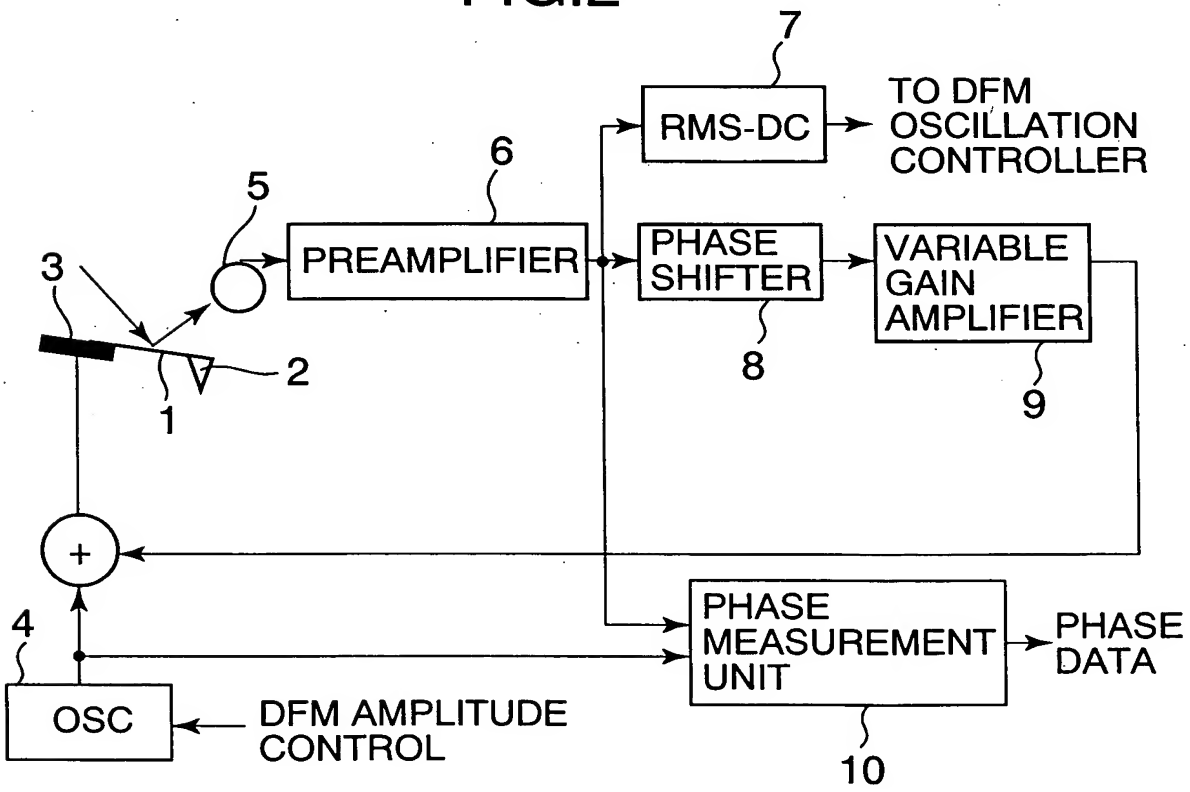

7
RMS-DC
TO DFM OSCILLATION CONTROLLER
6
5
PREAMPLIFIER
PHASE SHIFTER
VARIABLE GAIN AMPLIFIER
3
2
1
8
9
+
4
PHASE MEASUREMENT UNIT
PHASE DATA
OSC
DFM AMPLITUDE CONTROL
10

FIG.3

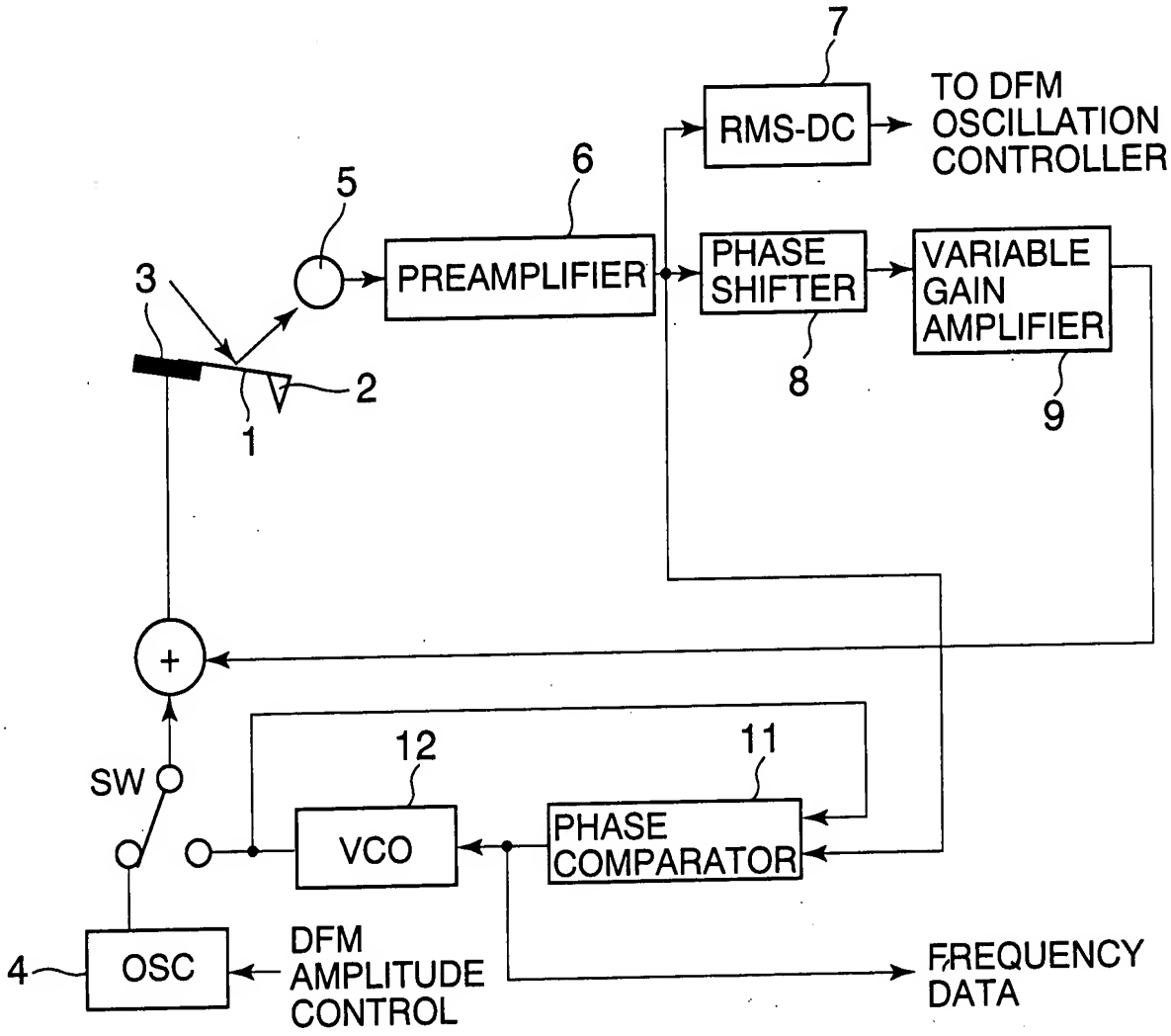

7
RMS-DC
TO DFM OSCILLATION CONTROLLER
6
5
PREAMPLIFIER
PHASE SHIFTER
VARIABLE GAIN AMPLIFIER
3
2
1
8
9
+
12
11
SW
VCO
PHASE COMPARATOR
4
OSC
DFM AMPLITUDE CONTROL
FREQUENCY DATA

FIG.4

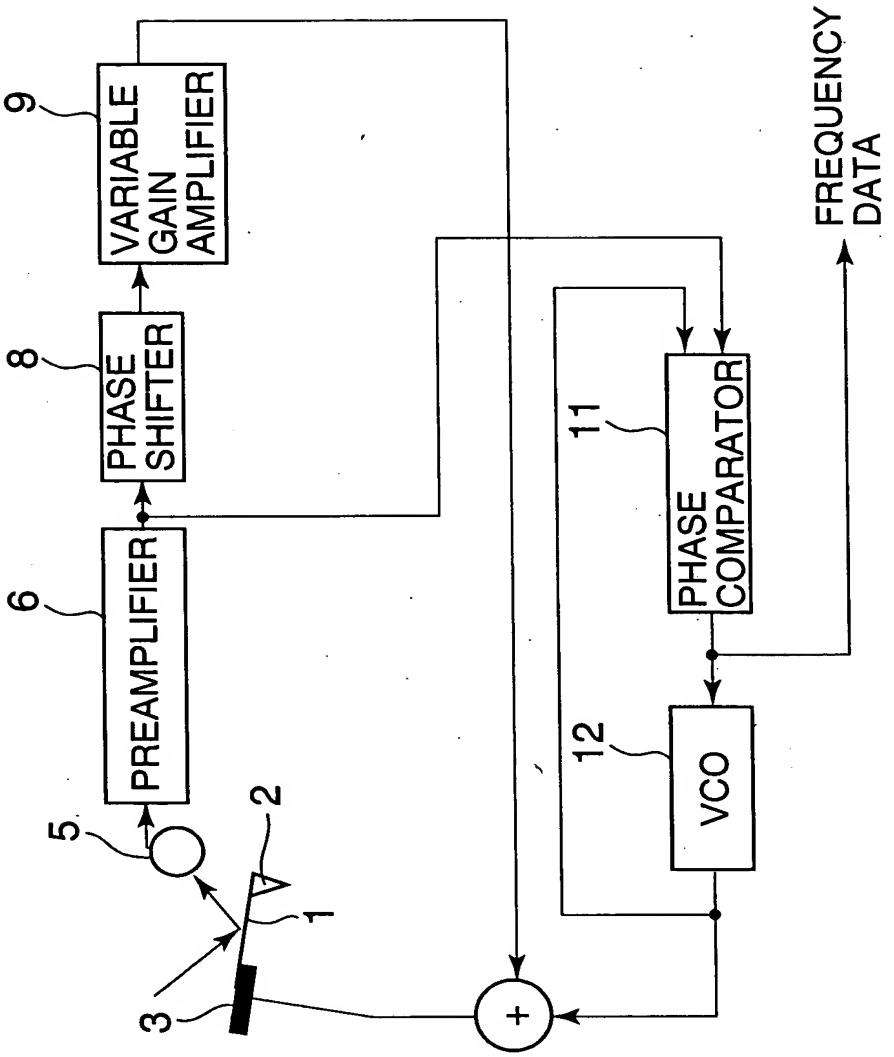
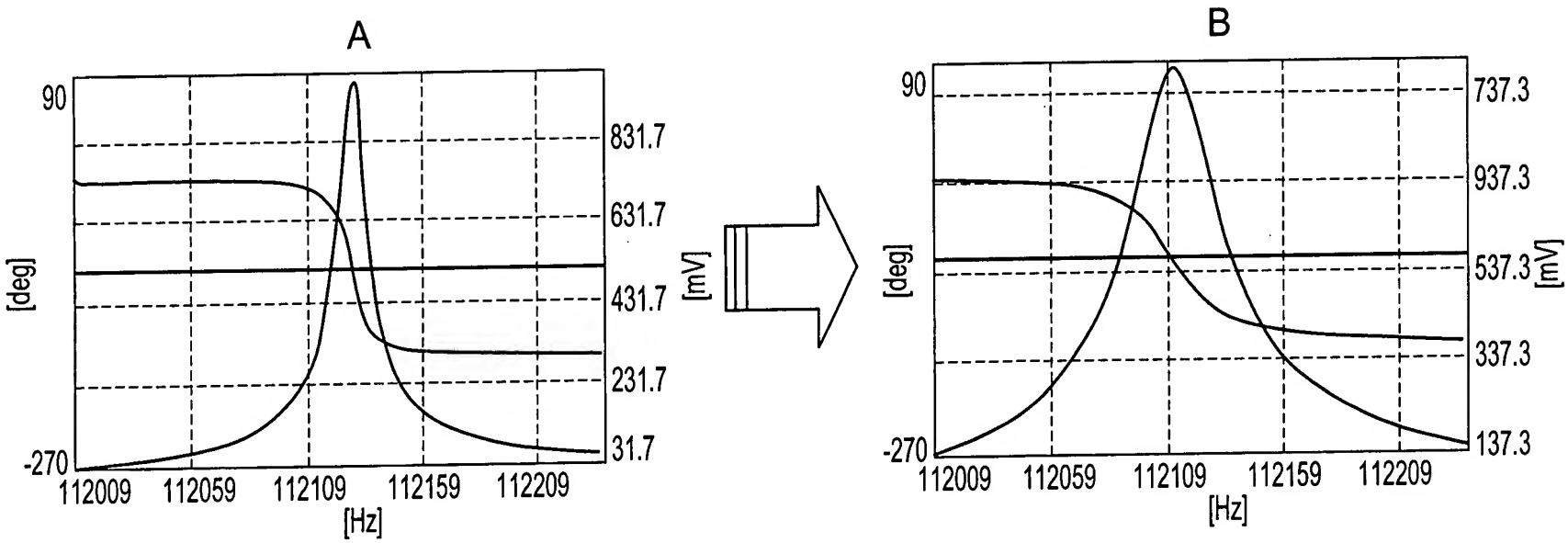

9
VARIABLE GAIN AMPLIFIER
8
PHASE SHIFTER
6
PREAMPLIFIER
5
2
1
3
+
11
PHASE COMPARATOR
12
VCO
FREQUENCY DATA

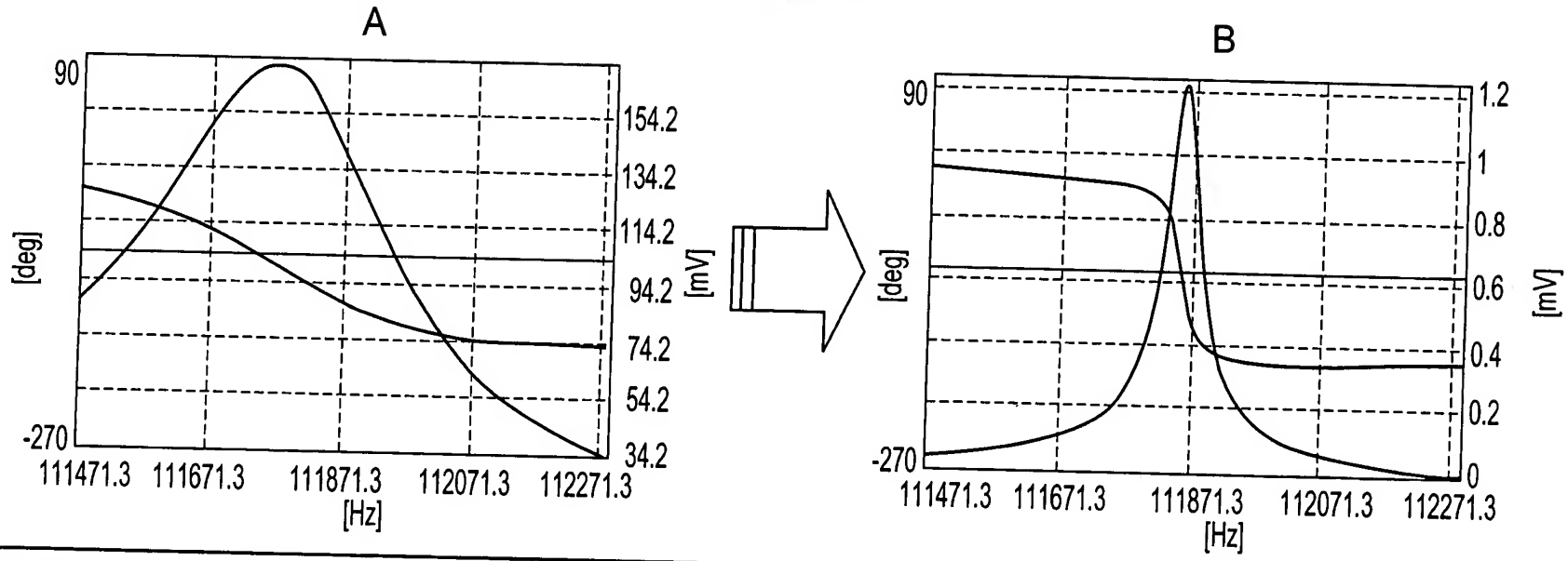
FIG.5



MEASUREMENT FREQUENCY	UPPER LIMIT	112.236 kHz	SET FREQUENCY	112.128 kHz
	LOWER LIMIT	112.009 kHz	OSCILLATION AMPLITUDE	0.981 V
MEASUREMENT GAIN		1.001		
EXCITATION VOLTAGE		0.071 V	RESONANCE FREQUENCY	112.128 kHz
LOW-PASS FILTER		5.0 kHz		
HIGH-PASS FILTER		1.0 kHz	ΔF	0.010 kHz
PHASE		-95.666 deg		
FILE NAME: BEFORE q-CONTROL.xjq			Q-VALUE	10957.620
COMMENT 1: VACUUM Q=11000				

MEASUREMENT FREQUENCY	UPPER LIMIT	112.236 kHz	SET FREQUENCY	112.112 kHz
	LOWER LIMIT	112.009 kHz	OSCILLATION AMPLITUDE	0.994 V
MEASUREMENT GAIN		1.001		
EXCITATION VOLTAGE		0.249 V	RESONANCE FREQUENCY	112.112 kHz
LOW-PASS FILTER		5.0 kHz		
HIGH-PASS FILTER		1.0 kHz	ΔF	0.034 kHz
PHASE		-90.149 deg	Q-VALUE	3277.861
FILE NAME: AFTER q-CONTROL.xjq				
COMMENT 1: VACUUM Q=3300 cont.				

FIG.6



MEASUREMENT FREQUENCY	UPPER LIMIT	112.284 kHz	SET FREQUENCY	111.638 kHz
	LOWER LIMIT	111.471 kHz	OSCILLATION AMPLITUDE	0.140 V
MEASUREMENT GAIN		1.001		
EXCITATION VOLTAGE		0.200 V	RESONANCE FREQUENCY	111.751 kHz
LOW-PASS FILTER		5.0 kHz		
HIGH-PASS FILTER		1.0 kHz	ΔF	0.321 kHz
PHASE		-56.663 deg		
FILE NAME: q BEFORE IMPROVEMENT.xjq			Q-VALUE	347.866
COMMENT 1: ATMOSPHERE Q=347				

MEASUREMENT FREQUENCY	UPPER LIMIT	112.284 kHz	SET FREQUENCY	111.839 kHz
	LOWER LIMIT	111.471 kHz	OSCILLATION AMPLITUDE	1.084 V
MEASUREMENT GAIN		1.001		
EXCITATION VOLTAGE		0.200 V	RESONANCE FREQUENCY	111.855 kHz
LOW-PASS FILTER		5.0 kHz		
HIGH-PASS FILTER		1.0 kHz	ΔF	0.043 kHz
PHASE		-46.135 deg		
FILE NAME: q AFTER IMPROVEMENT.xjq			Q-VALUE	2604.564
COMMENT 1: ATMOSPHERE Q=2604				

FIG.7A

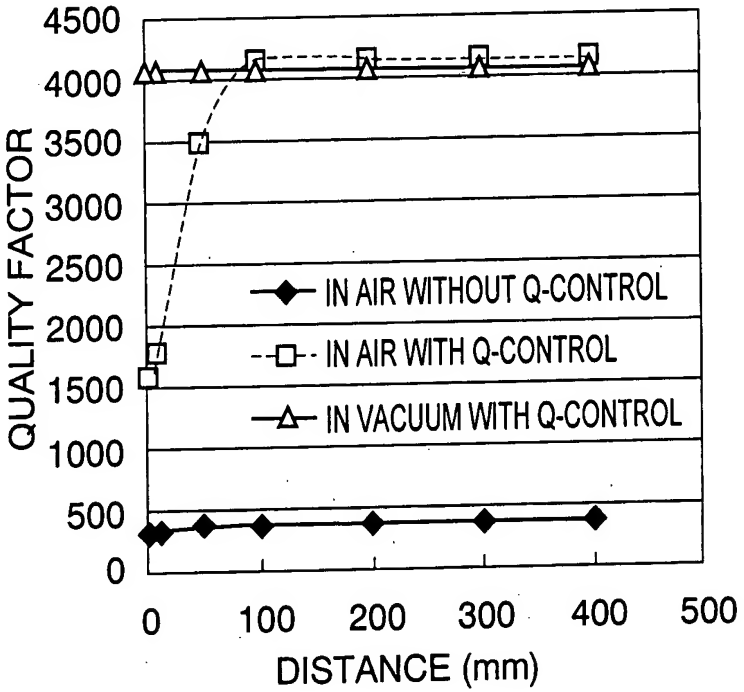

4500
4000
3500
3000
2500
2000
1500
1000
500
0
QUALITY FACTOR
IN AIR WITHOUT Q-CONTROL
IN AIR WITH Q-CONTROL
IN VACUUM WITH Q-CONTROL
0
100
200
300
400
500
DISTANCE (mm)

FIG.7B

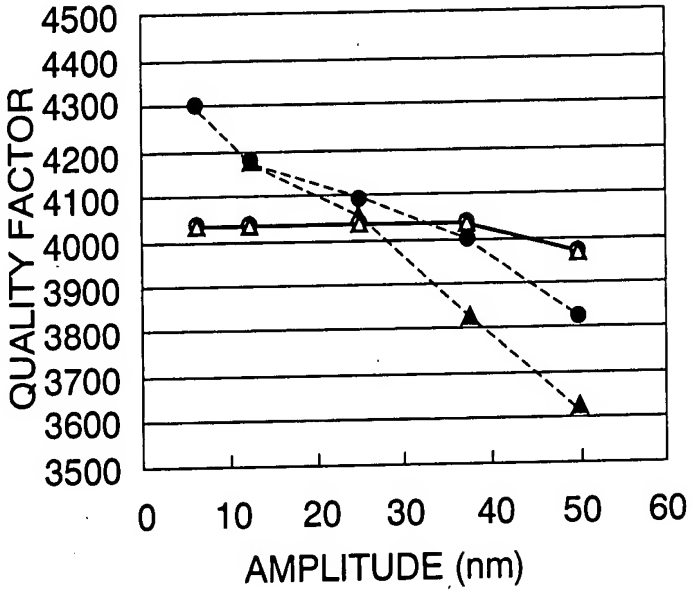

4500
4400
4300
4200
4100
4000
3900
3800
3700
3600
3500
QUALITY FACTOR
0
10
20
30
40
50
60
AMPLITUDE (nm)

FIG.8

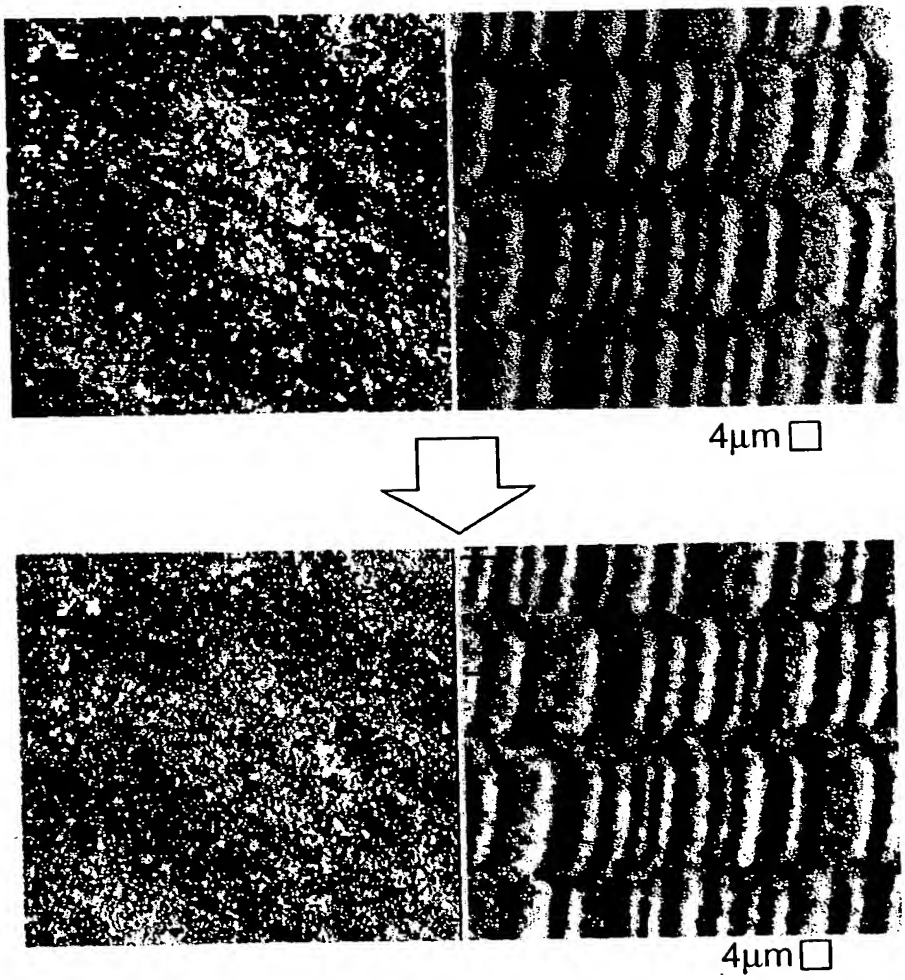


FIG.9

FIG.10A

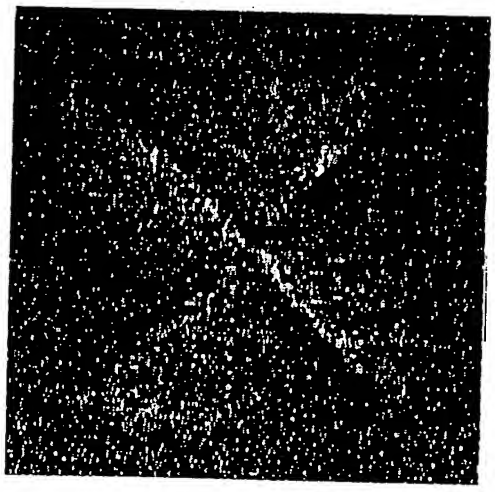


FIG.10B

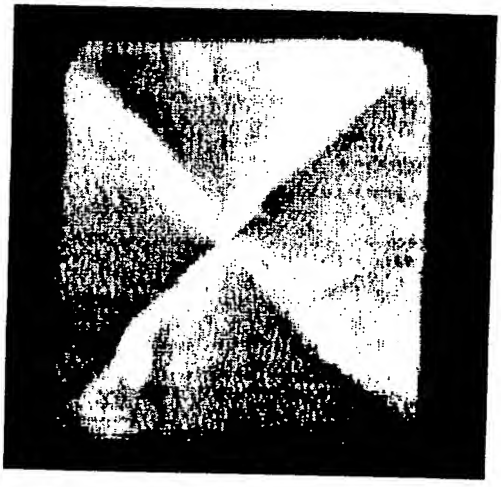


FIG.11

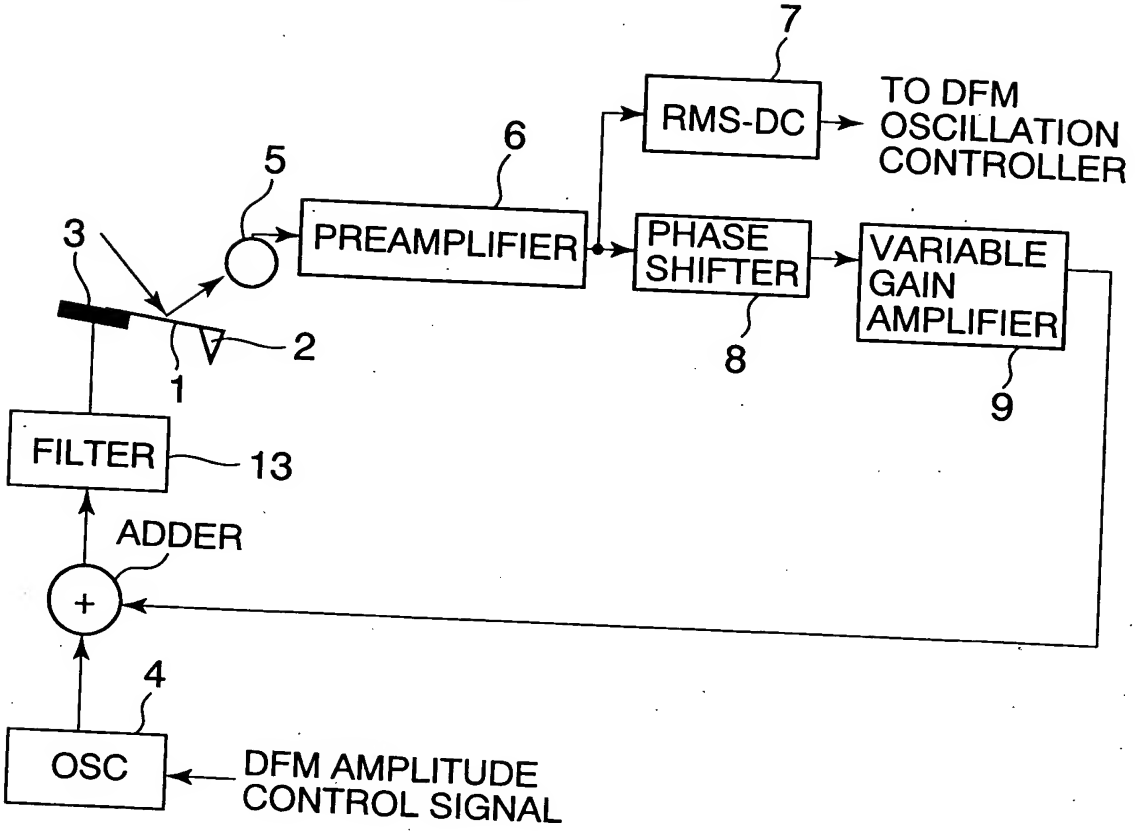
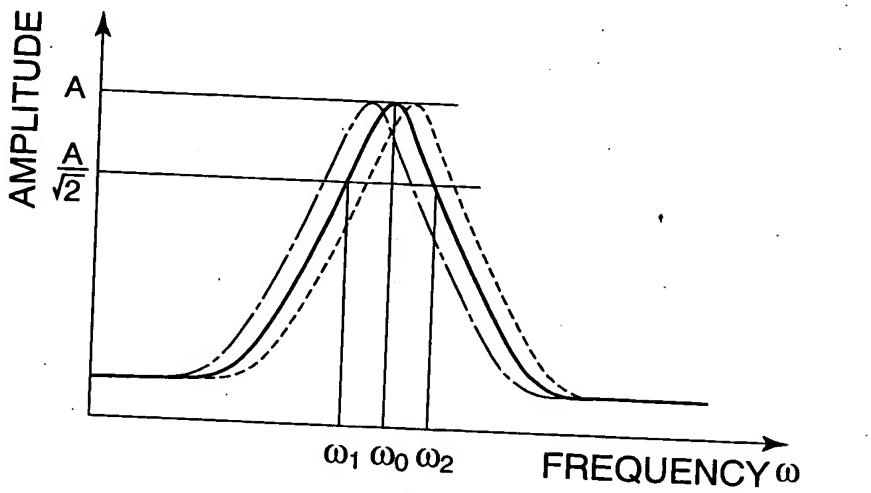


FIG.12



——— : WHEN THERE IS NO FORCE
– – – : WHEN THERE IS ATTRACTIVE FORCE
------ : WHEN THERE IS REPULSIVE FORCE

FIG.13

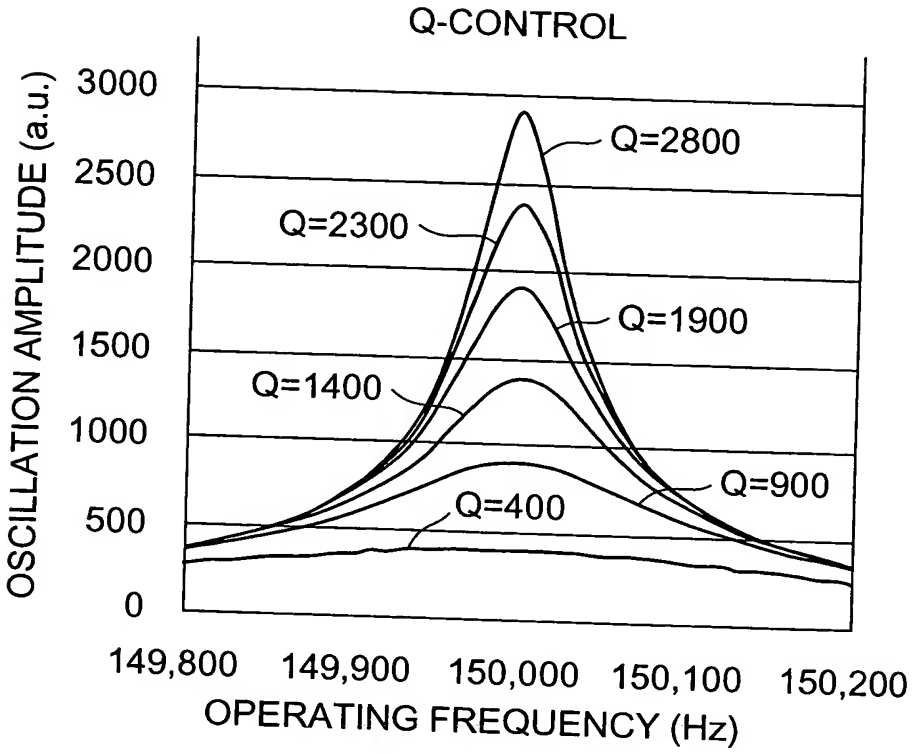
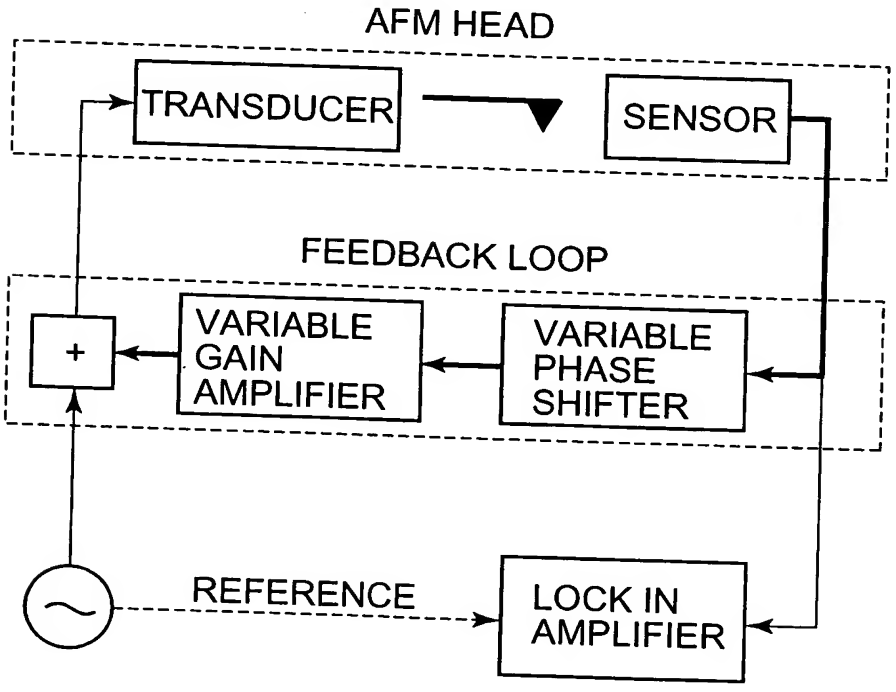

Q-CONTROL
OSCILLATION AMPLITUDE (a.u.)
3000
2500
2000
1500
1000
500
0
Q=2800
Q=2300
Q=1900
Q=1400
Q=900
Q=400
149,800
149,900
150,000
150,100
150,200
OPERATING FREQUENCY (Hz)

FIG.14


AFM HEAD
TRANSDUCER
SENSOR
FEEDBACK LOOP
+
VARIABLE GAIN AMPLIFIER
VARIABLE PHASE SHIFTER
REFERENCE
LOCK IN AMPLIFIER